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INTRODUCTION TO THE TNO DATA ARCHIVE

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1. INTRODUCTION

TNO started building a data archive in 1990. This resulted in a first publication in 1992 [1]. In 1993 noise team 6 'Community Response' of the International Commission on Biological Aspects of Noise (ICBEN) formulated as its main objective for the period 1993-1998: "enhancing the possibilities to benefit from other researchers' data" [2]. Triggered by this objective TNO intensified its efforts to organize a data archive.

Why was a data archive built in the first place? The reason for this can be explained as follows. In numerous studies data have been collected about annoyance caused by environmental noise. Unfortunately this does not mean that a clear picture exists about the relationship between noise exposure and annoyance. The results of different surveys are often difficult to compare because of differences in the way both exposure and annoyance data are collected and variables are defined.

Several attempts have been made to integrate the results of individual exposure response surveys. The most ambitious and very influential attempt was made in 1978 by Schultz [3]. This attempt did not remain undisputed [e.g. 4]. In 1991 Fidell, Barber and Schultz extended the original compilation of Schultz and arrived at the same exposure response curve [5]. Fields [6] reviewed both the original and the updated synthesis. The overall conclusion of his review is that much can be improved in the process of establishing a synthesized curve.

The objective of the TNO researchers with the data archive is to establish exposure response functions which describe the relation between annoyance experienced in and around the house in the recent past (say, three months to one year) and measures for the sound exposure during that period, for steady state situations. They try to benefit

as much as possible from the work of Schultz, Fidell and coworkers, and the general considerations put forward by Kryter, Fields and others in their reviews of this work.

2. FEATURES OF THE ARCHIVE

In this data archive first the original data were included of the Netherlands noise-annoyance projects conducted by TNO and other institutes during the past 25 years. Next the original data of several foreign surveys were acquired and included. The archive now includes over 40.000 effective cases from 28 surveys in 9 countries. An "effective case" is a respondent for whom at least one exposure measure and at least one annoyance rating could be determined. More cases are added regularly.

Table 1 gives an overview of the effective numbers of respondents per noise source; table 2 gives an overview of the effective numbers of respondents per country.

Table 1. Effective number of respondents per noise source

Noise source	effective number of respondents
civil aircraft	21545
road traffic	15687
rail traffic	4097
total	41329

Table 2. Effective number of respondents per country

Country	effective number of respondents
Australia	3198
Canada	3534
France	2113
Germany	3297
Netherlands	4739
Norway	1548
Switzerland	1371
UK	13639
USA	7895

While building the archive, TNO had to solve problems of various nature in making different exposure variables and annoyance variables comparable. Data may be collected at distinct time intervals, for example to investigate the effect of a change in operation conditions of the source or of an insulation program. As our first objective is concerned with steady states, only the data collected in a first round before any change took place are used.

Exposure Variables

In the scope of this paper it is not possible to describe in detail the procedures, used to make the exposure data mutual comparable. Only the "red threads" will be highlighted.

If possible, the three following exposure measures have been derived for each study: $L_{Aeq}(24h)$, L_{dn}, and L_{etm}. The latter measure is used in the Netherlands and is defined as the maximum of $L_{Aeq}(7\text{-}19h)$, $L_{Aeq}(19\text{-}23h) + 5$, and $L_{Aeq}(23\text{-}7h) + 10$. If the variables needed to calculate these measures were not available in a data set, they were estimated if there was sufficient basis to do so. In addition to the data sets sometimes information from a report, an article or personal communication was used for such an estimation. In some cases such additional information consisted of a combination of maximum levels and durations, or of traffic intensity as a function of the time of day.

Annoyance variables

The concept of "annoyance" had been made operational in a number of ways. By now consensus on the desirability of at least some features begin to show. Suggestions for harmonization can be found in [7]. In [1] and [7] also a routine is presented for comparing scales with different numbers of response categories and a different labelling of these categories. Here the major suggestions for harmonization and a global outline of the routine for comparing scales are summarized. For a more detailed description see [7].

Summary of major suggestions for harmonization. The annoyance question refers to a specific noise source, to the recent past (three months to one year), is not preceded by a filter based on perception or annoyance, and is unipolar. Furthermore there are at least four response categories, preferably 10 or 11, and there is a gradual transition of degree of annoyance expressed by the response categories. Finally the noise sources mentioned in various annoyance questions should be described on the same - not too high and not too low - abstraction level.

Routine for comparing annoyance scales. If annoyance scales with different numbers of categories have been used, their midpoints or boundaries are translated by a rule into a score in the range 0 - 100 for analyses using pooled data. Whether midpoints or boundary scores are needed, depends on the kind of analysis. If *percentages* of respondents,

reporting at least a certain level of annoyance as a function of the level of exposure, are required, boundary scores are needed. Comparable boundary scores as well as midpoints are most easily found if the following two assumptions can be made:

- equal intervals: each category from a single system occupies an equal portion of the annoyance continuum;
- equal extremes: the lower and upper outer category boundaries from different category systems coincide.

When these assumptions are met, the boundary scores and midpoint scores presented in table 3 can be used. They depend only on the number of categories. The boundary scores are determined as follows: (score for category boundary i) = 100i/m, where m is the number of categories and i = 1,..,m-1 is the rank number of the category, starting at low annoyance. The category midpoint scores are determined as follows: (score for category i) = 100 (i - ½)/m, where m is the number of categories and i = 1,..,m is the rank number.

Table 3. Boundary and midpoint scores for different category systems

number of categories	boundary scores	midpoint scores
3	33 - 67	17 - 50 - 83
4	25 - 50 - 75	13 - 37 - 63 - 87
5	20 - 40 - 60 - 80	10 - 30 - 50 - 70 - 90
6	17 - 33 - 50 - 67 - 83	8 - 25 - 42 - 58 - 75 - 92
7	14 - 28 - 43 - 57 - 72 - 86	7 - 21 - 36 - 50 - 64 - 79 - 93
10	10 - 20 - .. - 80 - 90	5 - 15 - .. - 85 - 95

Schultz [3] used a cut-off at boundary score 72. He called this percentage the percentage "highly annoyed". Kryter argued for a lower cut-off point [4]. For clarity and to stress the often neglected fact that annoyance percentages are rather meaningless without reference to the cut-off point. In order to get the percentages annoyed corresponding to these cut-off points for different category systems, the cumulative percentages at the nearest category boundaries on either side have to be (linearly) interpolated if the cut-off point does not correspond to the value for a category boundary determined as described above.

Unfortunately, category labels may lead to violation of the 'equal intervals' and 'equal extremes' assumptions. To account for the effect of verbal labels it may be necessary to join some adjacent categories before the above rules for assigning scores to midpoints and boundaries are applied. The categories obtained by such adjustments are referred to as the *effective categories*.

4. PARTICIPATION IN AND BENEFITING FROM THE DATA ARCHIVE

Several examples are available of meta-analyses conducted on the data archive, leading to more convincing conclusions than those derived from each single survey included in the analysis. One such example was presented in [8]. The data in the archive make it possible to compare between noise sources, between countries and between specific situations. In principle, also developements over time can be monitored.

The archive will enable any noise researcher to compare his/her data with these of other scientists. How does this work? When a data set is made available to TNO, the researcher receives a copy of his/her "standardized" data set in return, and a comparison between the own annoyance data and the most recently published update of the response function for the noise source(s) in question. More detailed comparisons and other analyses can be carried out together in joint projects, or by TNO at request.

Making available a data set usually does not require much effort. It is sufficient to have the data available on computer tape or discs, and to send the data set to TNO together with the written report and other relevant publications. TNO conducts all necessary routines to standardize the data set.

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